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## TEMPERATURE EFFECT ON CAPILLARIES OF LIQUID AND VAPOR PRESSURE THERMOMETERS

(EQUIPMENT SECTION TEST REPORT)



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(11)

# TEMPERATURE EFFECT ON CAPILLARIES OF LIQUID AND VAPOR PRESSURE THERMOMETERS.

## OBJECT.

The purpose of this test was to determine the temperature effect on capillaries of vapor and liquid pressure thermometers.

## CONCLUSIONS.

Vapor pressure thermometers are not appreciably affected by a change of capillary temperature.

Liquid pressure thermometers are subject to large errors when a relatively large temperature difference exists between the bulbs and capillaries.

## PROCEDURE.

The apparatus was set up as shown in figure 2. The bulbs were heated in a water bath by increments of 5° C. to about 80° C., while the capillaries were allowed to remain at room temperature. The capillaries (10-inch segment) were then heated in a paraffin bath by 5° C. increments to 240° C., while the bulbs were kept at a constant temperature of about 80° C. The data as indicated in the following table were observed and recorded at each temperature change.

## DISCUSSION.

Figure 1 shows plainly the characteristics of the two types of thermometers. If the entire length of their capillaries (instead of 10-inch central segment) had been heated, the error in the case of the liquid-filled thermometer would have been increased several times, but that of the vapor-filled thermometer would hardly have been affected.

The Boyce liquid-filled thermometer shows an unusually large error of 11½° C. for a temperature difference of 158° C. between its bulb and capillary. The direct linear expansion of the inclosed liquid is responsible for this error. Liquid-filled thermometers are not appreciably affected by a change of external pressure on account of the high internal pressure of the liquid (about 800 pounds per square inch). The scales of these instruments are open and uniform and they are reliable at all temperatures within their range, provided there is no great temperature difference between the bulbs and capillaries.

The national gage vapor-filled thermometer was not appreciably affected by a change of temperature of its capillary. The error was at no time greater than ±1½° C., although the temperature difference between its bulb and capillary was raised to 158° C. The coefficient of expansion of a gas is so small that no noticeable change in gage reading was indicated.

The vapor pressure of a liquid increases very rapidly with an increase in temperature. For this reason the scale is closed at low temperatures and open at high temperatures. Vapor pressure thermometers are seriously affected by a change of external pressure of the vapor.

## DATA.

Barometer ..... 29.3"  
Room and gage temperature ..... 24° C.  
12-foot capillaries, 10-inch central segment heated.

Read- ing.	Type "D," No. 1892-N, Na- tional gage ther- mome- ter read- ing, ° C.	Error.	Model "E," No. 32381, Boyce ther- mome- ter read- ing, ° C.	Error.	Tem- perature of bulbs, ° C. std.	Tem- perature of capil- laries, ° C. std.	Tem- perature differ- ence, bulbs and cap- illaries, ° C.
1	17	+3½	13	-1½	13½	21	.....
2	22½	+1	22	+½	21½	21½	0
3	23	-2	25½	+½	25	21½	-1 3½
4	25	-5	31	+1	30	21½	-8½
5	32	-3	35	0	35	21½	-13½
6	37	-3	40	0	40	21½	-18½
7	43	-2	45	0	45	21½	-23½
8	48	-2	50	0	50	21½	-28½
9	54	-1	55	0	55	22	-33
10	58½	-1½	60	0	60	22	-38
11	63½	-1½	65½	+½	65	22	-43
12	69½	-½	71	+1	70	22	-48
13	74½	-½	76	+1	75	22	-53
14	79½	-½	81½	+1½	80	22	-58
15	84	-1	86½	+1½	85	22	-63
16	88½	-1½	91½	+1½	90	22	-68
17	93½	-1½	96½	+1½	95	22	-73
18	81½	+1	82	+1½	80½	25	-55½
19	80	+½	81½	+1½	79½	30	-49½
20	78½	-½	80	+1½	78½	35	-43½
21	79	-½	81	+1½	79½	40	-39½
22	79	-½	81½	+1½	79½	45	-34½
23	79	-½	81½	+2	79½	50	-29½
24	79	-½	81½	+2	79½	55	-24½
25	79	-½	82	+2½	79½	60	-19½
26	79	-½	82	+2½	79½	65	-14½
27	79	-½	82	+2½	79½	70	-9½
28	79½	-½	82½	+2½	80	75	-5
29	80	-½	82½	+2½	80½	80	-1
30	81	+½	83	+2½	80½	85	+4½
31	81	+½	83½	+3	80½	90	+9½
32	81	+½	84	+3½	80½	95	+14½
33	81	+½	84½	+3½	80½	99	+18½
34	80½	0	84	+3½	80½	100	+19½
35	80	0	83	+3	80	105	+25
36	79	-½	82½	+3½	79½	110	+30½
37	78½	-1	82½	+3½	79½	115	+35½
38	79½	-½	82½	+3½	80	120	+40
39	80½	0	84½	+3½	80½	125	+44½
40	80½	0	84½	+4	80½	130	+49½
41	80	-½	84½	+4	80½	135	+54½
42	79	-1	84	+4½	79½	140	+60½
43	78½	-1½	83½	+4½	80	145	+65½
44	78	-1½	83½	+4½	79½	150	+70½
45	78	-1½	84	+4½	79½	155	+75½
46	78	-1	84	+5	79	160	+81
47	79½	-½	85	+4½	80½	165	+86½
48	79	-1	84½	+4½	80	170	+90
49	79½	-½	85	+4½	80½	175	+94½
50	79½	-½	85½	+5	80½	180	+99½
51	80	-½	86	+5½	80½	185	+104½
52	80½	-1	86½	+5½	81	190	+109½
53	81	-½	87½	+6	81½	195	+113½
54	81½	-½	88	+6	82	200	+118
55	81½	-½	89½	+7½	82	205	+123
56	80½	-½	90	+9½	80½	210	+129½
57	80½	-½	91	+10½	80½	215	+134½
58	80½	-½	91	+10½	80½	220	+139½
59	80½	-½	91½	+10½	81	225	+144
60	81	-½	92	+10½	81½	230	+148½
61	81	-½	92½	+11½	81½	235	+153½
62	81½	-½	93½	+11½	81½	240	+158½

<sup>1</sup> Started to vibrate gages.

<sup>2</sup> Began heating capillaries.

<sup>3</sup> Bath changed to paraffin. Room temperature, 22° C.

<sup>4</sup> Test renewed next day. Room temperature, 22° C.

<sup>5</sup> Paraffin ignited at about 243° C., flash point.

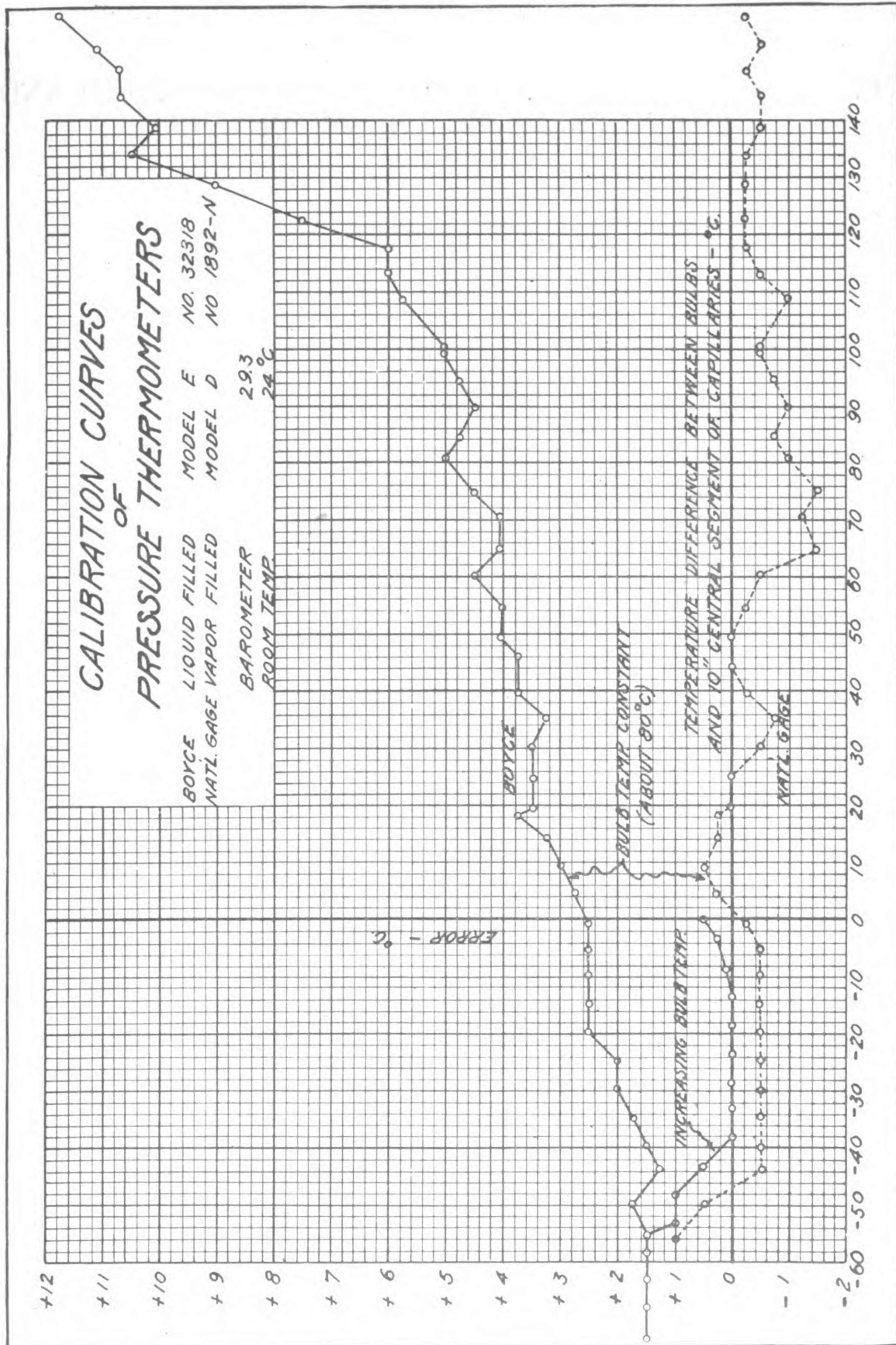


FIG. 1.

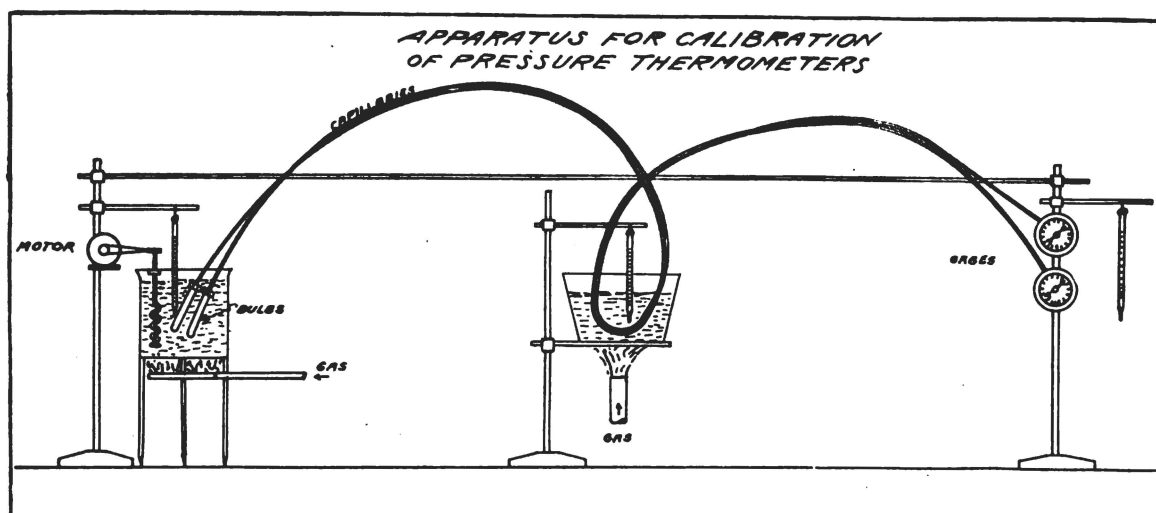


FIG. 2.

